

**CLINICAL OBSERVATIONS
FROM
RADIATION THERAPY**

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CLINICAL / COSMIC RADIATION DIFFERENCES

- **Time - dose schedules**
- **Particle species and energies**
- **Volume's irradiated**
- **Clinical studies 1st 70 years --- survival**
- **Clinical studies past 20+ years --- normal tissue injury and functional changes**

TISSUES

RELATIVE RADIOSENSITIVITY

TISSUES

RELATIVE SENSITIVITY

- **Lymphoid; Hemopoietic;
spermatogenic; ovarian; follicular &
intestinal epithelium**

High

- **Epidermal epithelium; urinary
bladder epithelium; esophageal
epithelium; optic lens epithelium;
gastric gland epithelium; ureteral
epithelium**

Fairly high

TISSUES

RELATIVE RADIOSENSITIVITY

TISSUES	RELATIVE SENSITIVITY
Connective tissue: interstitial tissues; neurological tissues; fine vasculature; growing cartilage or bone	Medium
Mature cartilage or bone; mucous or serous glands; salivary gland; sweat gland; nasopharyngeal; pulmonary; renal; hepatic; pancreatic; pituitary; thyroid and adrenal epithelium	Fairly low
Neuronal tissue; muscle tissue	Low

ORGAN RELATIVE RADIOSENSITIVITY

ORGAN	RELATIVE SENSITIVITY
• Lymphoid, bone marrow, testes, ovaries, intestines	High
• Skin & other organs with epidermal epithelial lining: urinary bladder; ureters; cornea; oral cavity; esophagus; rectum; vagina; uterine cervix; etc.	Fairly high

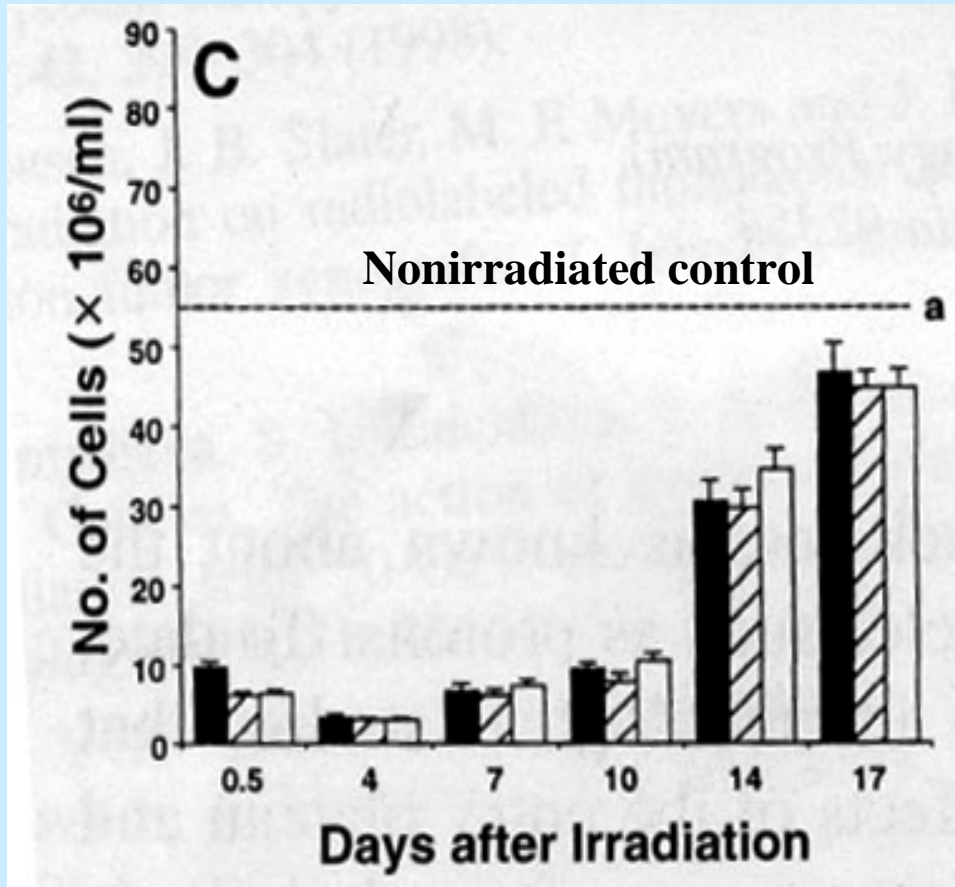
ORGAN RELATIVE RADIOSENSITIVITY

ORGAN	RELATIVE SENSITIVITY
<ul style="list-style-type: none">• Growing cartilage; fine vasculature; growing bone	Medium
<ul style="list-style-type: none">• Mature cartilage or bone; salivary gland, respiratory organs; kidneys; liver; pancreas; thyroid; pituitary; and adrenal glands	Fairly low
<ul style="list-style-type: none">• Muscle; brain; spinal chord	Low

SPECIFIC CLINICAL OBSERVATIONS

- **Time / dose / volume / particle species and energy all modify radiobiological effects**
- **Lymphocyte blood count depressed early**
- **White blood count and platelet count reduced**
- **Immune responses depressed**
- **Modulation of cytokine serum levels occur**

Acute Effects of Whole-Body Proton Irradiation on the Immune System of the Mouse



Number of lymphocytes in spleen following single dose (3 GY) of:

■ 250 MeV protons at spread out Bragg peak

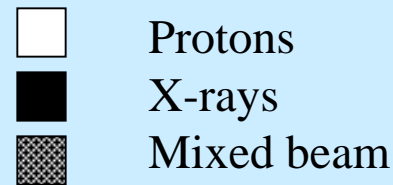
▨ 250 MeV protons at entrance region

□ ^{60}Co

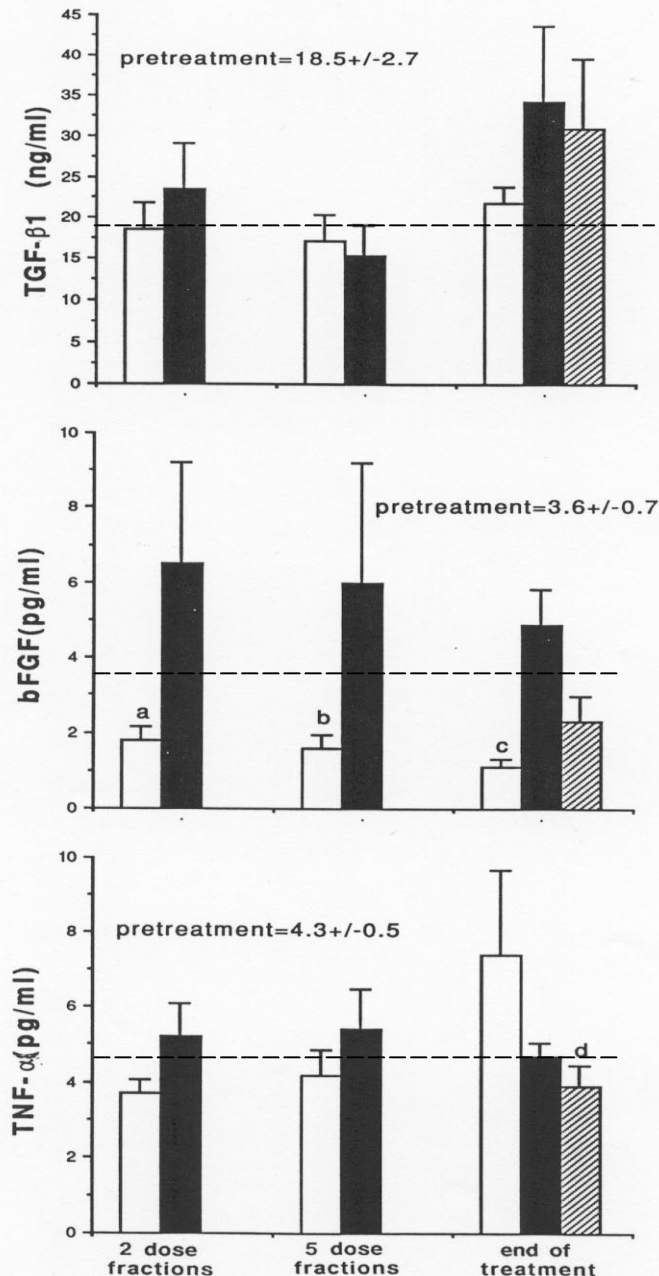
SPECIFIC CLINICAL OBSERVATIONS

- **Regional fibrosis common**
- **Extensive fibrosis occurs in some patients**
- **Functional changes in CNS include mild temporary depression & apathy in some patients**
- **Energy loss mild to severe**
- **Partial organ vs. whole organ effects (radiation protective measures)**

Pilot study of cytokine profiles in prostate cancer patients undergoing proton or conventional radiotherapy



- X-rays all had higher integral dose because of larger field size
- Modulation found with all cytokines studied



Gridley et al 1995

CONCLUSION

- Clinical observations suggest need for long term low dose rate studies simulating cosmic environment for:
 - ◆ Cell survival of the high sensitivity tissues
 - ◆ Potential synergism with additional pulsed high dose rate radiation
 - ◆ Functional changes in lymphoid and hemopoietic tissues, i.e. Immune system function
 - ◆ CNS functional changes
 - ◆ Radiation protection measures